Effects of Restaurant and Bar Smoking Regulations on Exposure to Environmental Tobacco Smoke Among Massachusetts Adults

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Environmental tobacco smoke (ETS) exposure has been shown to cause respiratory illnesses, including lung cancer, childhood asthma, and lower respiratory tract infections, as well as having developmental and cardiovascular effects.[1–3] Exposure to ETS is unevenly distributed across the US working population. Food service workers—waiters, waitresses, cooks, bartenders, and counter help—are the least likely group to be covered by smoke-free policies.[4,5]

To protect restaurant patrons and employees, many communities have adopted regulations restricting smoking in bars and restaurants. These restrictions vary from less stringent policies to total bans in which smoking is prohibited with no exceptions. Intermediate policies include restriction of smoking to enclosed, separately ventilated areas. Importantly, provisions exist that provide loopholes in these policies, such as variances from regulations and exemptions for particular circumstances.[6]

In our study, we sought to (1) examine the association of local clean indoor air regulations with adult exposure to ETS in Massachusetts restaurants and bars and (2) specify the relation between the strength of local regulations and exposure in these establishments. To the best of our knowledge, this is the first investigation to quantitatively examine the effects of local restaurant and bar smoking regulations on exposure to ETS through the use of a representative state sample.

METHODS

Data were derived from a larger longitudinal study, carried out between January 1, 2001, and June 15, 2002, designed to examine the impact of community-based tobacco control interventions on adult and youth smoking behavior. In that study, interviewers from

Objectives. We examined the association of local restaurant and bar regulations with self-reported exposure to environmental tobacco smoke among adults.

Methods. Data were derived from a telephone survey involving a random sample of Massachusetts households.

Results. Compared with adults from towns with no restaurant smoking restrictions, those from towns with strong regulations had more than twice the odds of reporting nonexposure to environmental tobacco smoke (odds ratio [OR]=2.74; 95% confidence interval [CI]=1.97, 3.80), and those from towns with some restrictions had 1.62 times the odds of reporting nonexposure (OR=1.62; 95% CI=1.29, 2.02). Bar smoking bans had even greater effects on exposure.

Conclusions. Strong local clean indoor air regulations were associated with lower levels of reported exposure to environmental tobacco smoke in restaurants and bars. (*Am J Public Health.* 2004;94:1959–1964)

the Center for Survey Research of the University of Massachusetts at Boston conducted 20-minute random-digit-dialing telephone surveys involving a random sample of Massachusetts households with telephones. Smokers, young adults, and recent quitters were oversampled. Sixty-six percent of eligible households were successfully screened during the study period, and interviews were completed with 70% of the eligible respondents, resulting in a sample of 6739 adults aged 18 years or older.

Measures

We examined 2 outcome measures related to ETS exposure in bars and restaurants. Both were determined by adults' responses to the following questions: "In the past 12 months, when you were eating in a restaurant in [town], how often did you see someone smoking?" and "In the past 12 months, when you were out at a bar or club in [town], how often did you see someone smoking?" In the case of each of these items, the interviewer read the actual name of the town in which the respondent reported residing at the time of the interview.

To answer these questions, adults first had to report that they had dined at a restaurant or visited a bar or club in their town in the past 12 months and that they did so at least

rarely. As a result, sample sizes were restricted to 5394 and 2466 for analyses of exposure in restaurants and bars, respectively. We created binary variables indicating "nonexposure" (never or rarely) or "exposure" (sometimes, often, or always) to ETS in restaurants and bars.

Explanatory Variables

Town of residence. The zip code of each respondent was obtained in the screening interview. In the case of town-specific questions, interviewers gathered information from respondents about their town of residence. This information was later cross-referenced to zip code and a list of the 351 Massachusetts towns. The 65 cases in which the town name used for questioning was not the respondent's actual town of residence were excluded, limiting the overall sample sizes to 5339 for the restaurant analyses and 2433 for the bar analyses.

Restaurant and bar regulations. We acquired data on local restaurant smoking regulations in place in each of the 351 cities and towns in Massachusetts during the survey period (January 2001 through July 2002). More complete descriptions of this database have been presented elsewhere.[6] Using actual town of residence, we linked individuals' survey re-

TABLE 1—Descriptive Statistics for Analysis Variables

	Total, % (No.)	95% Confidence Interval
Strength of restaurant ordinance[a]		
Weak	63.7 (4254)	62.6, 64.9
Medium	22.4 (1492)	21.4, 23.4
Strong	13.9 (928)	13.1, 14.7
Strength of bar ordinance[b]		
Weak	89.0 (5941)	88.3, 89.8
Strong	11.0 (733)	10.2, 11.7
Gender		
Male	42.5 (2837)	41.3, 43.7
Female	57.5 (3837)	56.3, 58.7
Race/ethnicity		
White	83.5 (5530)	82.6, 84.4
Non-White	16.5 (1095)	15.6, 17.4
Age, y		
18–44	54.6 (3630)	53.4, 55.8
≥45	45.4 (3022)	44.2, 46.6
Education, y		
<16	58.3 (3809)	57.1, 59.5
≥16	41.7 (2722)	40.5, 42.9
Income, $		
≤30 000	21.2 (1167)	20.2, 22.3
>30 000	78.8 (4330)	77.7, 79.9
Marital status		
Not married	42.2 (2689)	41.0, 43.4
Married	57.8 (3680)	56.6, 59.1
No. of children in household		
0	59.6 (3972)	58.4, 60.8
≥1	40.4 (2688)	39.2, 41.5
Smoking status		
Nonsmoker	81.5 (5437)	80.5, 82.4
Current smoker	18.5 (1237)	17.6, 19.5
Frequency of dining out at restaurants in town[c]		
Low	62.9 (3381)	61.6, 64.2
High	37.1 (1992)	35.8, 38.4
Frequency of visiting bars or nightclubs in town[c]		
Low	68.9 (1680)	67.1, 70.8
High	31.1 (757)	29.2, 32.9
Town residents voting "yes" on Question 1, %		
<50	58.4 (3894)	57.2, 59.5
≥50	41.6 (2780)	40.5, 42.8

Note. All distributions are based on valid cases only.
[a]We categorized restrictions as "weak" (no enclosed, separately ventilated areas), "medium" (smoking allowed in enclosed, separately ventilated areas only), or "strong" (smoking prohibited, including in bar areas, with no variances).
[b]We categorized restrictions prohibiting smoking with no variances as "strong" and all other restriction categories as "weak."
[c]Responses were dichotomized into "low" (rarely or sometimes) and "high" (often or always).

areas; or prohibited in restaurant dining or bar areas (or both) and (2) whether variances (exceptions or exemptions to the regulations) were permitted. In the analyses specific to restaurants, we categorized restrictions as "weak" (no enclosed, separately ventilated areas), "medium" (smoking allowed in enclosed, separately ventilated areas only), or "strong" (smoking prohibited, including in bar areas, with no variances). If a regulation prohibited smoking but a variance existed, the restaurant was coded in the "medium" category. In the bar and club analyses, we categorized restrictions prohibiting smoking with no variances as "strong" and all other restriction categories as "weak."

Control variables. In our model estimates, we controlled for years of education (less than 16 vs 16 or more), marital status (married vs nonmarried), number of children aged younger than 18 years living in the household (0 vs 1 or more), and gender. As a result of initial analyses revealing that younger adults were more likely to frequent restaurants and bars than older adults, we dichotomized respondents into 2 age groups (18–44 years and 45 years or older). Race and ethnicity were also combined to create 2 groups (non-Hispanic White and non-White). Data on household income were obtained through asking respondents to select the income category that best described their total household income, before taxes, in the past year. Family-level income was dichotomized into 2 categories ($30 000 or less and $30 001 or more).

We also controlled for individual-level smoking status. "Current smokers" were classified as those who reported having smoked at least 100 cigarettes in their lifetime and currently smoked "every day or some days"; "nonsmokers" were categorized as those who currently smoked "not at all" and those who had not smoked 100 cigarettes in their lifetime.

A potential confounding variable was respondents' frequency of dining out at restaurants and visiting bars and clubs in their own towns. Adults who patronize restaurants and bars at high rates may do so in other towns as well as their own, obscuring the effect of town-level ordinances. Respondents who reported having dined out at a restaurant in the past 12 months were asked "When you go out to eat, how often do you go to restaurants

sponses to the level of regulation effective in their town on the date of the interview.

To measure the strength of local regulations, we recorded provisions vital to protec-

tion from ETS exposure in restaurants and bars, including (1) whether smoking was allowed; restricted to designated areas; restricted to enclosed, separately ventilated

TABLE 2—Exposure to Environmental Tobacco Smoke in Restaurants and Bars, by Strength of Local Ordinance

Strength of Ordinance[a]	Nonexposure, % (95% CI)	Exposure, % (95% CI)	Unadjusted OR[b] (95% CI)
	Restaurants[c]		
Weak	55.8 (53.3, 58.4)	44.2 (41.6, 46.7)	1.00
Medium	70.2 (66.1, 74.0)	29.8 (26.0, 33.9)	1.87* (1.50, 2.31)
Strong	81.2 (76.2, 85.4)	18.8 (14.6, 23.8)	3.42* (2.49, 4.69)
	Bars[d]		
Weak	10.4 (8.4, 12.7)	89.6 (87.3, 91.6)	1.00
Strong	51.8 (41.9, 61.5)	48.2 (38.5, 58.1)	9.27* (5.85, 14.68)

Note. OR = odds ratio; CI = confidence interval.
[a]$P<.01$ for overall χ^2 test.
[b]Reflects the likelihood of not being exposed to environmental tobacco smoke in restaurants or bars.
[c]We categorized restrictions as "weak" (no enclosed, separately ventilated areas), "medium" (smoking allowed in enclosed, separately ventilated areas only), or "strong" (smoking prohibited, including in bar areas, with no variances).
[d]We categorized restrictions prohibiting smoking with no variances as "strong" and all other restriction categories as "weak."
*$P<.01$, from logistic regression analysis.

in [town]?" Responses were dichotomized to represent low restaurant attendance (rarely or sometimes) and high restaurant attendance (often or always).

A similar question was asked of respondents who reported having visited a bar or nightclub in the past 12 months: "When you go out to bars and nightclubs, how often do you go to bars and clubs in [town]?" Responses were dichotomized to represent low bar/club attendance (rarely or sometimes) and high attendance (often or always) in the respondent's town of residence. "Never" responses were excluded because those reporting never going to restaurants, bars, or clubs were not queried regarding exposure to tobacco smoke in these establishments.

Contextual town-level variables. Since this was a cross-sectional analysis, we were not able to establish with certainty whether reported exposure levels were a consequence of the regulations or whether another variable (e.g., antismoking sentiment in the town) was responsible for variations in both regulations and exposure. In an effort to control for town-specific antismoking sentiments preceding the implementation of restaurant and bar regulations in Massachusetts, we included a dichotomous indicator of whether or not 50% or more of the voters in the respondent's town had voted in favor of Question 1 in 1992, the ballot initiative that created the Massachusetts tobacco control program.

Data Analysis

We first examined the bivariate association between strength of local regulations and reported ETS exposure in restaurants and bars. To determine statistical significance, we used χ^2 tests and their associated *P* values. We then performed multivariate logistic regression analyses examining the effects of regulation strength on ETS exposure while controlling for potential confounding variables. We used an iterative model building procedure[7] to select a parsimonious model for the data. We assessed the significance of variables using likelihood ratio tests in which the alpha level was set at .10.

All variables with missing values were modeled as categorical variables. We used indicator variables to code the categorical variables and included a "missing" category for each variable so that the full data set of adult respondents could be examined in each analysis. The regression coefficients corresponding to missing data categories are not shown in the tables, because they were not of interest; however, none of these coefficients were significant. All analyses were weighted to adjust for the oversampling of smokers, young adults, and recent quitters.

RESULTS

Descriptive statistics for variables used in the analyses are presented in Table 1. During the study period, only 13.9% of respondents lived in a town with a regulation that endorsed the highest level of protection from ETS exposure in restaurants. The majority of adults resided in towns characterized by "weak" regulations regarding exposure in restaurants (63.7%), while about one fifth lived in towns with medium-level restaurant regulations (22.4%). Only 11.0% of respondents resided in towns with regulations supporting the highest level of protection from ETS in bars; the remainder (89.0%) lived in towns with "weak" bar regulations.

Weighted percentages indicated that 57.5% of the respondents were female, 83.5% were Caucasian, and 54.6% were between the ages of 18 and 44 years. Most were married (57.8%), and 40.4% reported the presence of at least one child in their household. In terms of socioeconomic indicators, 41.7% of respondents had attained at least a college education, and 78.8% reported a household income greater than $30 000 in the past year. During this time period, 18.5% of respondents were classified as current smokers, while 28.6% lived in a household with at least one adult smoker.

Of the respondents who had ever dined at restaurants in their towns, 37.1% reported doing so often or always. Of respondents who had ever visited a bar or club, 31.1% reported high patronage of these establishments. Finally, 41.6% of the respondents lived in towns in which the majority of residents had voted "yes" on Question 1.

Bivariate analyses (Table 2, top) show a graded association between strength of restaurant regulations and reported ETS exposure. Of the adults living in towns characterized by weak regulations, for example, 55.8% reported not being exposed to ETS in restaurants, as compared with 70.2% of those residing in towns with medium-level regulations and 81.2% of those residing in towns with strong regulations ($P<.01$). Relative to respondents residing in towns with weak regulations, those living in towns with medium-level regulations had 1.9 times the odds of not being exposed to ETS (95% confidence interval [CI] = 1.50, 2.31), while those residing in towns with strong regulations had 3.4 times the odds of nonexposure (95% CI = 2.49, 4.69).

TABLE 3—Adjusted Odds Ratios for Nonexposure to Environmental Tobacco Smoke in Restaurants

	Full Model,[a] Adjusted OR[c] (95% CI)	Final Model,[b] Adjusted OR[c] (95% CI)
Main predictor variable		
Strength of ordinance[d]		
Weak	1.00	...
Medium	1.65** (1.32, 2.07)	1.62** (1.29, 2.02)
Strong	2.79** (2.00, 3.89)	2.74** (1.97, 3.80)
Control variables		
Gender		
Male	1.00	...
Female	1.05 (0.88, 1.26)	...
Age, y		
18–44	1.00	1.00
≥45	1.42** (1.16, 1.74)	1.46** (1.20, 1.77)
Race/ethnicity		
White	1.00	...
Non-White	1.07 (0.83, 1.38)	...
Education, y		
<16	1.00	...
≥16	1.06 (0.87, 1.30)	...
Income, $		
≤30 000	1.00	...
>30 000	0.83 (0.65, 1.05)	...
Marital status		
Not married	1.00	...
Married	1.15 (0.95, 1.40)	...
No. of children in household		
0	1.00	1.00
≥1	1.21*** (0.98, 1.48)	1.26* (1.04, 1.53)
Smoking status		
Nonsmoker	1.00	...
Current smoker	1.04 (0.89, 1.22)	...
Frequency of dining out at restaurants[e]		
Low	1.00	...
High	1.01 (0.84, 1.21)	...
Town residents voting "yes" on Question 1, %		
<50	1.00	1.00
≥50	1.66** (1.35, 2.03)	1.65** (1.35, 2.00)

Note. OR = odds ratio; CI = confidence interval.
[a]Including all control variables, regardless of significance of contribution to the model.
[b]Determined through an iterative model selection procedure and including variables that contributed significantly to the model according to log-likelihood ratio test with alpha level of .10.
[c]Reflecting the likelihood of not being exposed to environmental tobacco smoke.
[d]We categorized restrictions as "weak" (no enclosed, separately ventilated areas), "medium" (smoking allowed in enclosed, separately ventilated areas only), or "strong" (smoking prohibited, including in bar areas, with no variances).
[e]Responses were dichotomized into "low" (rarely or sometimes) and "high" (often or always).
*$P<.05$; **$P<.01$; ***$P<.10$.

clubs was 9.27 (95% CI=5.85, 14.68) among respondents who lived in towns with strong regulations relative to those who lived in towns with weak regulations.

Table 3 presents results from an extension of the analysis, including estimates from the full (column 1) and final (column 2) adjusted logistic regression models predicting nonexposure to ETS in restaurants. The gradient effect of restaurant regulations on nonexposure was unchanged after control of possible confounding factors. In the full model, odds ratios for nonexposure were 1.65 (95% CI=1.32, 2.07) and 2.79 (95% CI=2.00, 3.89) in restaurants associated with medium-level and strong regulations, respectively. Being older and married, having at least one child in the household, and residing in a town in which 50% or more of the residents voted yes on Question 1 were associated with nonexposure in restaurants. Interestingly, individual smoking status was not significantly associated with nonexposure in restaurants.

The final model (column 2, Table 3) for nonexposure in restaurants highlighted the regulation gradient effect; the odds ratios associated with each level of regulation remained unchanged from those observed in the full model. The single strongest predictor of nonexposure to ETS in this model was living in a town with strong restaurant regulations; adults living in these towns had almost 3 times (odds ratio [OR]=2.74; 95% CI= 1.97, 3.80) the odds of not being exposed to ETS in restaurants as those residing in a town with weak regulations. Age, presence of children in the household, and town-level vote on Question 1 remained significantly associated with nonexposure ($P<.01$).

A similar pattern can be seen in Table 4 for nonexposure in bars and nightclubs. In the full model, the odds ratio of nonexposure was 7.47 (95% CI= 4.59, 12.22) among adults living in towns with strong regulations relative to those living in towns with weak regulations, holding constant all other measures. Being older and married, reporting less frequently visiting bars or nightclubs, and living in a town with a vote of 50% or greater in favor of Question 1 increased the likelihood of reporting nonexposure to ETS in town restaurants.

A similar relationship was found in the case of bars and clubs (Table 2, bottom). Among those who lived in towns with the strongest regulations specific to bars and clubs, 51.8% reported nonexposure, as compared with only 10.4% of those living in towns with weak regulations ($P<.01$). The odds ratio of nonexposure in bars or night-

TABLE 4—Adjusted Odds Ratios for Nonexposure to Environmental Tobacco Smoke in Bars and Clubs

	Full Model,[a] Adjusted OR[c] (95% CI)	Final Model,[b] Adjusted OR[c] (95% CI)
Main predictor variable		
Strength of ordinance[d]		
Weak	1.00	1.00
Strong	7.47** (4.59, 12.22)	7.26** (4.47, 11.76)
Control variables		
Gender		
Male	1.00	…
Female	1.07 (0.71, 1.62)	…
Age, y		
18–44	1.00	1.00
≥45	1.88** (1.21, 2.91)	1.88** (1.22, 2.90)
Race/ethnicity		
White	1.00	…
Non-White	1.44 (0.81, 2.58)	…
Education, y		
<16	1.00	…
≥16	0.81 (0.53, 1.25)	…
Income, $		
≤30 000	1.00	…
>30 000	0.94 (0.49, 1.81)	…
Marital status		
Not married	1.00	1.00
Married	1.53*** (0.97, 2.41)	1.46*** (0.96, 2.24)
No. of children in household		
0	1.00	…
≥1	1.00 (0.62, 1.61)	…
Smoking status		
Nonsmoker	1.00	…
Current smoker	0.78 (0.54, 1.12)	…
Frequency of visiting bar or nightclub[e]		
Low	1.00	1.00
High	0.50** (0.30, 0.85)	0.48** (0.29. 0.82)
Town residents voting "yes" on Question 1, %		
<50	1.00	1.00
≥50	3.32** (2.21, 5.00)	3.05** (2.00, 4.65)

Note. OR = odds ratio; CI = confidence interval.
[a]Including all control variables, regardless of significance of contribution to the model.
[b]Including only those variables that contributed significantly to the model according to log-likelihood ratio test.
[c]Reflecting the likelihood of not being exposed to environmental tobacco smoke.
[d]We categorized restrictions prohibiting smoking with no variances as "strong" and all other restriction categories as "weak."
[e]Responses were dichotomized into "low" (rarely or sometimes) and "high" (often or always).
*$P < .05$; **$P < .01$; ***$P < .10$.

In the final bar and club model, living in a town with strong regulations was the strongest predictor of nonexposure in these establishments. The odds ratio of nonexposure was 7.26 (95% CI = 4.47, 11.76) among respondents living in towns with the highest levels of protection from ETS in bars relative to those living in towns with weaker regulations. Age, marital status, frequency of visiting bars, and town-level vote on Question 1 remained significantly associated with nonexposure ($P < .01$). Again, smoking status was not associated with nonexposure.

DISCUSSION

We began our analysis with 2 main goals: (1) to examine the effects of local clean indoor air regulations on ETS exposure in restaurants and bars and (2) to specify the effects of varying levels of local regulations (from weak to strong) on reported exposure.

Results clearly showed that more restrictive restaurant and bar regulations are associated with lower levels of reported ETS exposure in restaurants and bars among adult residents of Massachusetts. Those living in towns with strong regulations had approximately a 3-fold greater likelihood of nonexposure to smokers in restaurants relative to those living in towns with weak regulations. Those residing in towns with mid-level regulations had more than 1.5 times the odds of not being exposed to ETS in restaurants as adults in towns with weak regulations. Most striking in this study was the relation between strength of bar regulation and reported exposure; adults living in towns in the strong category had a 7-fold greater likelihood of nonexposure to smokers relative to those residing in towns with regulations in all other categories.

Interestingly, individual smoking status was not significantly associated with nonexposure to ETS in restaurants and bars. This may have been attributable to the fact that smokers see decreasing numbers of smokers in restaurants and bars, as a result of shifts toward more restrictive smoking policies, and thus are less likely to smoke in these establishments. This finding may also reflect changing norms related to the social unacceptability of smoking in restaurants and bars. That is, smokers may perceive there to be fewer smokers as a result of these changing social norms, even in restaurants and bars where smoking is present. Future research will profit from investigating the role of smoking status in self-reported ETS exposure in these venues.

Importantly, the regulation gradient was not reduced by adjustment for sociodemographic, behavioral, or town-level characteristics in the multivariate models. Such robust findings were unexpected in light of consider-

able factors—at both the individual and the town level—that heavily favor a finding of no effect. All else being equal, strength of regulation was the strongest predictor of nonexposure to ETS in restaurants and bars.

Several limitations of this study should be acknowledged. First, the outcome variable did not assess ETS exposure directly; rather, respondents were asked how often they see smokers when they go to restaurants or bars in their town. Although this is an indirect measure of exposure, it has been shown that self-reported data on number of smokers one sees at a particular location is highly correlated with levels of ETS exposure, as confirmed by ambient nicotine measurements.[8] Coghlin et al. found that once the number of smokers one sees and the total number of hours one sees these smokers are taken into account, further information (including proximity of smokers and intensity of smoking) adds little to estimation of exposure according to nicotine levels.[8]

The ETS exposure assessment literature indicates that self-reports of seeing smokers (or being in the presence of smokers) represent a valid measure of biochemically confirmed exposure levels.[9–11] According to Repace, the single most important predictor of ETS exposure levels is density of smokers in an environment[12–14]; thus, frequency of seeing smokers in an environment is well supported as a measure of assessing ETS exposure in that environment. Moreover, given the limitations of this measure, the fact that we detected strong effects only strengthens our findings.

Second, limitations inherent to our study design could have biased the results toward the null hypothesis. Because of the cross-sectional nature of this study, the results do not take into account the length of time in which regulations had been operational in each town. In our analyses, we included the ordinance that was in effect on the day of the adult's interview. This omission of "lag time" would presumably have diluted any effect, yet we found a strong influence of local regulations on ETS exposure.

A third limitation is that individuals are likely to dine out in towns other than their own, and this may be especially true of those living in small towns. Along the same lines, the question regarding seeing smokers in restaurants and bars assessed exposure over a 1-year period before establishment of the current regulations in a given respondent's town. In some cases, a regulation may not have been in effect for most of the period regarding which the adult was queried. Both of these factors could contribute to misclassification of the independent variable, biasing the results toward the null hypothesis. However, this proved not to be the case, suggesting that the true magnitude of the effect is probably stronger than what was observed in our study.

The main contribution of our study is that it validates, by means of self-reported ETS exposure, our clean indoor air coding system specific to restaurants and bars. Results revealed substantive differences in terms of exposure between regulations that restrict smoking to enclosed, separately ventilated areas only and those that prohibit smoking entirely. In that we examined the impact of regulations in regard to their intended aim—reducing exposure to ETS—the present findings support the reliability of our scale. Analytical distinctions in regulations were strongly associated with graded levels of reported exposure, validating the use of our coding system in future research investigating the effects of local restaurant and bar smoking regulations. ■

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Contributors

All of the authors contributed to conceptualization of the research question and the design of the study. A.B. Albers and M. Siegel conducted the data analysis and prepared the article. D.M. Cheng was responsible for analytic design, statistical and methodological guidance, and data interpretation. L. Biener was the principal investigator of the study and directed survey administration and data collection. All of the authors reviewed and edited the final version of the article.

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